

A NEW FAMILY OF BEETLES FOUND IN THE CANTHAROIDEA

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The superfamily Cantharoidea has been subjected to less concerted critical examination than most groups of beetles. This may be due to a number of reasons: these insects are often secretive in habit; they do not make particularly spectacular museum specimens, being soft and unmanageable, therefore not lending themselves to arrangement in martial ranks within a box; and that so many species are found in tropical areas where collecting tends to be more superficial than the more thorough canvass of areas such as Europe and United States.

Familial components of the superfamily have been open to considerable debate in the past and remain in a state of flux today. Many species of Cantharoidea have been described based on single specimens and occasionally it seems that specific differences are too slight to warrant that designation. In brief, the entire group appears to be in a rather nebulous state of alpha-taxonomy.

Leng (1920) considered the North American families of Cantharoidea to include Lycidae, Lampyridae, Phengodidae, Cantharidae, Drilidae, Melyridae, Cleridae, and Corynetidae. In his 1933 supplement the latter three families were removed to a new series, Cleroidea, in response to findings presented in Bøving and Craighead's synopsis of larval Coleoptera (1931). The change appears valid, as Cleroid adults have only 6 abdominal segments unlike Cantharoids which have either 7 or 8. Peyerimhoff (1933) and Blackwelder (1944) concurred with Bøving and Craighead, Blackwelder also recognizing a family, Karumiidae, as a member of Cantharoidea. Brues and Melander (1932) had used a system similar to that of Peyerimhoff and Blackwelder but erected a family, Rhagophthalmidae, which was later placed with the Lampyridae in their 1954 bulletin. Other modifications in 1954 by Brues and Melander were placement of Phengodidae with Cantharidae; Karumiidae with Drilidae; and formation of two new families, Atroctoceridae and Telegeusidae, apparently distinguished from their parent superfamily, Lymexyloidea, which has eight abdominal segments instead of six as well as major larval differences. Members of the superfamily have in common generally recognized primitive morphological features such as 7 or 8 abdominal segments, eleven antennal joints, and five tarsal segments on each leg.

Bøving and Craighead (1931) had divided the Cantharidae into four subfamilies because of larval characteristics. These were designated as Cantharinae, Malthinae, Malthodinae, and Chauliognathinae. The European system of classification of the Cantharidae, outlined in *Coleopterorum Catalogus—pars 165* (1939), treats various elements of the family as tribes, namely, Omethini, Podabrini, Cantharini, Silini, Ichthyurini, Malthini, and Chauliognathini. When considering the family on a world-wide

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basis this classification is perhaps to be preferred, since Bøving and Craighead's analysis of Cantharidae does not seem to include sufficient examples from localities outside of North America to draw positive conclusions. Again, zoogeographic evidence appears to support Delkeskamp's classification in *Coleopterorum Catalogus*. Therefore, in this paper, the European system will be followed. For correlative purposes, American authorities generally include the tribe Ichthyurini in Bøving and Craighead's subfamily Malthinae while the tribe Chauliognathini and their subfamily, Chauliognathinae, are synonymous.

During the past few years I have made an effort to determine relationships between the taxa of Cantharoidea considering as a major premise that as many factors as possible should be correlated before drawing sweeping conclusions. Previous studies of this type seem to place undue reliance on one or a few diagnostic features. This project has proved to be an unexpectedly difficult task. In the early stages of the study, "conservative" characters demonstrating taxonomic relationship among families were sought. Wing venation was soon found to be constant in a general way within a given family, being variable only in degree and no greater between genera than among species. Venational differences gave the first hint of unnatural elements among the familial taxa belonging to Cantharoidea. This was particularly manifest in the family Cantharidae. The wing venation of the Chauliognathini and Ichthyurini have patterns similar to one another but unlike those of the remaining elements of Cantharidae.

Following this discovery, these tribes were considered in detail for factors confirming their alliance and separating them from the remainder of the family. This study resulted in an abundance of morphological evidence suggesting that they are closely related and unlike Cantharidae.

Chauliognathidae, NEW FAMILY

Male genitalia of Chauliognathini and Ichthyurini are characterized by asymmetry in contrast to Cantharids, thus supporting my general impression that the new group is more specialized.

The median lobe (penis) is twisted nearly ninety degrees dextrally, necessitating lateral copulation. The tegmen, composed of a basal piece with right and left parameres fused to it, is separated from the median lobe by a wide membranous area except at a narrow point of union near the base of the right paramere. This paramere and median lobe presumably serve as claspers during copulation. The left paramere is much reduced or may be lacking in some species. The internal sac everts through the distal end of the penis.

Cantharid genitalia differ markedly, being entirely symmetrical. Some *Cantharis* retain the primitive tergum of the ninth abdominal segment as a genitalic segment. The basal piece of most Cantharidae forms a tubular structure through which the median lobe slides. Parameres are fused only to the basal piece which also has one or more paired ventral apophyses.

Using Lindroth and Palmen's (Tuxen, 1956) terminology, genitalia of both groups belong to the annulate group. Cantharid genitalia are clearly the classical annulate type. Chauliognathids are more difficult to explain.

The asymmetric condition may indicate a link to the Adephaga and Staphylinoidae. I believe coalescence of right paramere and median lobe to be secondarily acquired rather than being simply extensions of the condyle of the articulate form, since the basal piece is a well sclerotized tubular structure. Associated with the asymmetric aedeagus of Chauliognathini is a greatly inflated eighth abdominal sternal plate which is at least quite uncommon in Coleoptera (Figure 1).

The structure of the Chauliognathid abdomen is radically different from that of Cantharidae. In Chauliognathids the lateral edge is formed by the tergum whereas in Cantharidae the sternum forms the lateral edge (Figure 2). The pleural membrane in Cantharids is evident from the proximal to distal border of each segment. In dried specimens of Chauliognathini, the pleural membrane may be seen only at the extreme distal boundary while in Ichthyurini it is somewhat more extensive. The spiracles are located two-thirds forward from the distal edge of the pleural membrane of each abdominal segment in Chauliognathids. Cantharid spiracles are more variable in position, being one-fourth back from the proximal edge of the pleural area of each segment in *Cantharis*, one-half way from the proximal edge of the tergal area in *Podabrus*, and almost to the distal tergal edge but not at the extreme lateral edge in *Silis* and *Polemius*. Another point of familial differentiation is that Chauliognathid spiracles are concealed in dried specimens except for those located on the penultimate segment. In life, distention of the abdomen allows spiracles to be observed directly. Cantharid spiracles may easily be seen in dried specimens. These relationships of tergum, pleural membrane, sternum, and spiracles are not unduly surprising since it is well known that the limits of the definitive tergum and sternum are not necessarily similar to those of the primitive dorsal and ventral areas.

Chauliognathids have another abdominal structure useful in separating the group. Each extreme lateral distal tergal border bears a prominent round spiracle-like depression. Upon dissection, this seems to be glandular. The function is not known at this time.

Cantharoid wings have undergone considerable structural modification, making interpretation of venation difficult. Classical venational arrangements advanced by Comstock and Needham (1898-99) seem unsatisfactory to me so far as the very difficult Coleoptera are concerned. Forbes' (1922) system would, with some modification, appear to be more applicable, and will be used in this paper. Venational reductions which I believe to represent a more specialized and advanced condition occur in the new group. Figure 3 illustrates typical wing patterns of Cantharids, and figure 4, those of Chauliognathids. These families may easily be delimited using general wing venational patterns. Minor venational dissimilarity of several types may be discerned among genera and species: (1) fading of untracheated veins, (2) slightly different contact points, and (3) varying proximity to adjacent veins. A general trend toward further reduction is quite apparent. Australian Chauliognathids, for example, are in a much more advanced stage of vein fading than their western hemisphere counterparts.

Costa (C) is the leading vein in both Cantharids and Chauliognathids as well as all other Coleopterous families. It runs fully basad where an articulation with the metathorax may be found. A narrow membranous strip precedes the costa for its basal one-third.

The strong concave tracheated subcostal vein (SC) is similar in each taxon. Basally it unites with the anterior axillary sclerite which in turn forms an articulation with the metathorax, then runs very close to the costa after which a shift in direction results in union with the radius.

Radius (R) is a prominent tracheated convex vein arising from the same sclerite as does SC although these two veins are not united directly. R_1 continues nearly to the wing tip, uniting there with C in both groups. The vein elements in what is usually regarded as the radial stem (R_s) region are somewhat problematical to me. Forbes (1922) states that R_s is atrophied basally leaving an outer radial recurrent (R_r). Then, as the part of R_s crossing the wing fold atrophies, the second radial cross vein ($2r$) swings into this portion of R_s and is considered a part of R_r .

After examining a series of Cantharoids, I noted a progression of venational changes which do not seem to fit the hypothesis insofar as this superfamily is concerned. The swing of the $2r$ occurs prior to atrophy of R_r as may be particularly noted in Cantharidae. Here, although degenerate, R_r is still visible following juncture of $2r$ with $r-m$ and $R_s + 1r$. Forbes considered the vein in question to be $R_s + 2r$ while I feel that expressing it simply as $2r$ more accurately fits the situation in Cantharoidea. Chauliognathids have completely lost R_r but aside from this the radial system is similar to that of Cantharidae.

The medial vein (M) is virtually identical in both taxa being free basally, fusing with cubitus near the wing margin, and extending thence to the edge as $M_4 + CU$. Medius appears to have captured cubitus, then atrophied basally. An $r-m$ cross vein is present which is obscured at wing fold points.

Cubitus (CU) is a strong convex tracheated vein similar in all Cantharoidea. Basally it unites with a pre-axillary sclerite that also receives the second anal vein. The pre-axillary sclerite then articulates with the posterior axillary sclerite. Distally, union with M_4 has already been mentioned.

The principal diagnostic differences between Chauliognathids and Cantharids may be found among the anal veins which are vastly reduced in the former group. Interpretation of the anal vein group is difficult at best. Chauliognathids exhibit the greatest reduction of anal veins in the superfamily while Cantharids occupy a comparatively intermediate position.

The first anal vein (1st A) base has been captured by CU in both taxa but union with that vein has been lost due to the presence of a longitudinal wing fold. Chauliognathids have a simple 1st A unconnected with the balance of the anal vein system. Cantharid 1st A is complex being united in part with the second anal vein.

The second anal vein (2nd A) is well tracheated in each group. Chauliognathid 2nd A bifurcates to form what I take to be 2nd A_2 and 2nd A_3 . This represents a reduction from the situation found in Cantharids. There, 2nd A bifurcates twice. The first division gives rise to 2nd A_3 and

a second anal trunk (2nd A_t). The anal trunk quickly divides again forming 2nd A_2 which is completely free and 2nd A_1 which unites for a short distance with 1st A, then separates and extends nearly to the wing margin. The 2nd A_1 appears similar to a cross vein immediately prior to its connection with 1st A but close examination demonstrates its true nature.

The course of the third anal vein (3rd A) is easily ascertained after considering its development throughout the Cantharoid series. The third anal is captured by 2nd A which extends as a strong 2nd A_3 to the wing border in both Chauliognathids and Cantharids. Basally, 3rd A unites with the posterior axillary sclerite which also receives the simple fourth anal vein (4th A). This axillary sclerite then forms the principal articulation with the metathorax.

Elytra of most Cantharidae entirely cover the abdomen, the notable exception being found in Malthini where they are considerably abbreviated. This is also the situation in Ichthyurini and no doubt accounts for placement of this group with Bøving and Craighead's Malthinae in the past. The Chauliognathini have longer elytra which cover the abdomen completely in species of the Australian region and all but the terminal two or three abdominal segments in Neotropical and Nearctic forms. Full abdominal coverage would seem to be the primitive condition.

The thorax of Cantharoidea seems fundamentally conservative in structure as might be anticipated in a portion of the body utilized for the rather fundamental processes of walking and flying. However, even here we find some constant structural differences between the new group and Cantharidae.

Chauliognathid prosterna have a ventro-lateral flattened wing-like sclerotized projection just below the point of articulation with the head. This may vary somewhat in magnitude but is entirely lacking in Cantharidae. The metathoracic episterna narrows rapidly posteriomediaally forming an obtuse angle in Chauliognathids while in Cantharids the medial border of the episternum does not become narrowed being simply sinuate throughout its entire length. The metapleural post-alar bridge is considerably reduced in width and reflexed laterally in Cantharidae and is larger and rounded laterally in Chauliognathids.

The legs do not appear to have fundamental differences consistent enough to apply to either group as a whole. One feature was found, however, which seems diagnostic of Chauliognathids. They lack two distal tibial spurs which are prominent in Cantharidae. Observable tarsal peculiarities are apparently on specific or generic levels and are coupled with habits of the taxa involved. It was noted that most forms generally considered to be more or less quiescent have the fourth tarsal segments split longitudinally resulting in a two-fingered appearance. This condition presumably would be useful in grasping flower petal or leaf edges. The fifth tarsal joint is inserted very near the proximal end of the fourth. More vagile species lack split fourth tarsal segments and usually have more distally inserted fifth joints. Most Chauliognathids and *Polemios* have split tarsal segments while *Podabrus* and *Cantharis* generally have entire segments. Again, this feature seems to be associated with habits rather than demonstrating affinities.

The head structure of Chauliognathids is very interesting. In its study, a major difficulty lay in ascertaining which features were truly diagnostic of the family and which were in response to environmental conditions (Figure 5).

Strictly diagnostic characteristics appear to include foreshortened second antennal joints less than one-fourth the length of either the basal or third segment. Cantharid gular sutures range from fully divided in *Cantharis* to united in *Podabrus*. In Chauliognathids gular sutures are also united but lack the noticeable sulcus found in *Podabrus*. The terminal segment of the maxillary palpi of Cantharidae is sharply angular medially forming a rough triangle while in Chauliognathids it is essentially oblong with no sharp angulation.

Other Chauliognathid head structures are useful in diagnosis although when not considered from an adaptation standpoint may seem of questionable importance. Food habits are no doubt responsible for a large measure of the variation found in Chauliognathid mouth parts. Adult Nearctic and Neotropical *Chauliognathus* apparently are strict nectar and pollen feeders, the Ichthyurini are essentially carnivorous, and Australian *Chauliognathus* are more or less adapted to omnivorous habits. Ichthyurini do not possess the accessory protrusible labral lip and maxillary tongue found in Chauliognathini. Both structures are utilized in the rather specialized feeding of this tribe. The labral lip articulates with the clypeus and is moveable. In addition, the clypeus itself is articulated to the frons by a narrow unsclerotized area allowing some movement. The protrusible maxillary tongue is at least rare in the class Insecta. This structure is apparently used for "lapping" up nectar and pollen. The post labium of the highly specialized American hemisphere *Chauliognathus* is undivided forming a completely sclerotized spindle-shaped plate with a median longitudinal raised rib. The balance of Chauliognathids have a divided post labium forming a mentum and submentum connected by a flexible unsclerotized area. Cantharids also have a divided post labium but the submentum itself is again articulated transversely.

It is my opinion that New Guinea and Australian Chauliognathids are closest to the ancestral type. These forms, although presently placed with *Chauliognathus*, have foreshortened heads similar to Ichthyurini. Mandibular and maxillary dimensions follow head structure and are much less elongate in Australian forms ascribed to *Chauliognathus* and in Ichthyurini.

Finally, the Chauliognathid vestiture is of a finer shorter sort than Cantharid. Also, as a rule, Cantharidae are more cryptic in pigmentation.

The zoogeographic distribution of Chauliognathini and Ichthyurini is rather suggestive. These taxa are strongest in South America, Australia, and New Guinea, all of which are recognized refuges of relict species. One could logically assume the new group to have been once widespread and then later replaced elsewhere by other species. I do not wish to infer a process of being driven into these areas by superior competitors. Instead, cold intolerance of the vast majority of species in Chauliognathini and Ichthyurini points to range restriction during the late Tertiary followed by replacement in unoccupied areas. Further zoogeographic implications will be treated in another paper soon to be published.

The Chauliognathini as a group have a marked discontinuity of distribution. Over four-fifths of the known species are found in South America with but 28 in United States and Mexico north of the Mexican plateau (only 2 of these 28 extend beyond the reaches of southwestern United States). The remaining Chauliognathini are concentrated in New Guinea and Australia.

Ichthyurini are somewhat more widespread but as a group occur, as do Chauliognathini, in localities usually adjudged by zoogeographers to be "relict" areas. Over one-half of the known species inhabit the Oriental or Australian regions while one-fourth occur in the Neotropics. Twenty-four of thirty-one Ethiopian forms are found in the West African relict area. Five species have been described from Japan and nine species live in United States. The relict southwestern part of United States is the habitat of most North American species.

After consideration of the evidence it is therefore indicated and proposed that the taxa generally known as Chauliognathini and Ichthyurini, formerly classed with Cantharidae, be separated and included in a new family which, in accordance with the rules of priority, should be known as Chauliognathidae. The type genus is *Chauliognathus* as erected by Nicholas Hentz in 1830. I feel that differences in ecology and habits of

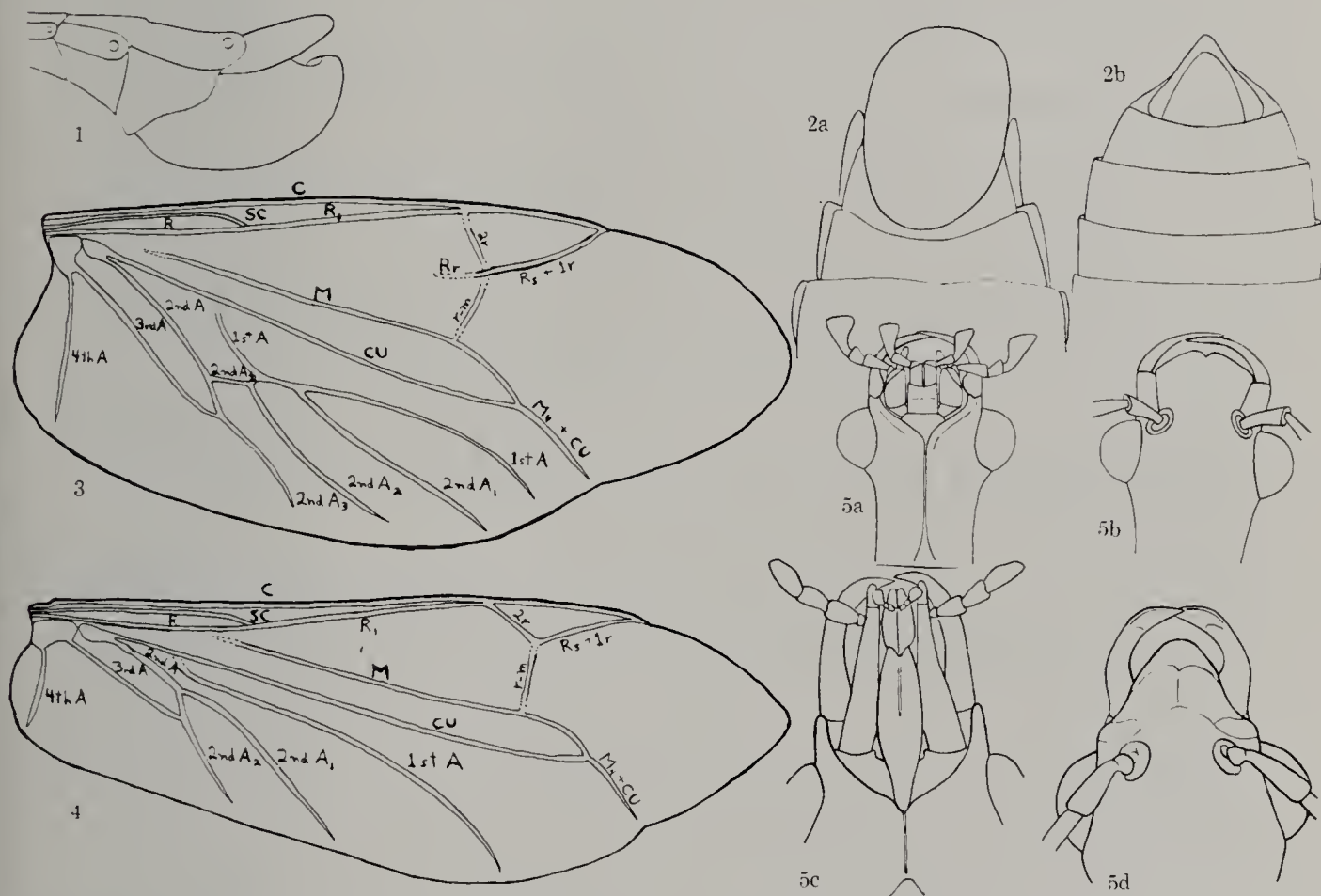


FIG. 1, Chauliognathid terminalia, lateral view; FIG. 2a, Chauliognathidae, abdomen, ventral view; FIG. 2b, Cantharidae, abdomen, ventral view; FIG. 3, Cantharidae, wing venation; FIG. 4, Chauliognathidae, wing venation; FIG. 5a, Cantharid (*Podabrus* sp.), mouthparts, ventral view; FIG. 5b, Cantharid (*Podabrus* sp.), mouthparts, dorsal view; FIG. 5c, Chauliognathid (*Chauliognathus* sp.), mouthparts, ventral view; FIG. 5d, Chauliognathid (*Chauliognathus* sp.), mouthparts, dorsal view.

the two main elements of the new family warrant retention of their status as tribes, namely Chauliognathini and Ichthyurini.

Previously described and new taxa included in Chauliognathidae are:

Chauliognathini LeConte

Chauliognathus Hentz (285 sp.)

South America
Central America
Mexico
United States
New Guinea
Australia

subgenus *Meloicantharis* Pic (1 sp.)
Brazil

Daiphron Gorham (33 sp.)

South America
Central America

subgenus *Microdaiphron* Pic (8 sp.)
Brazil

Psilorhynchus Blanchard (3 sp.)
Amazon-Orinoco Valley

Molychnus Motschulsky (1 sp.)
Colombia

Ichthyurini Champion

Ichthyurus Westwood (173 sp.)

Central America
Mexico
United States
West Central Africa
Eastern Asia
Philippines
Indonesia

subgenus *Microichthyurus* Pic
(13 sp.)
Philippines
Indonesia
Malaya
Indochina

Malthoichthyurus Pic (3 sp.)

South America
Central America

Selenurus Fairmaire (14 sp.)

Australia
Tasmania

Maronius Gorham (30 sp.)

South America

Macromalthinus Pic (1 sp.)

French Guiana

Belotus Gorham (22 sp.)

South America
Antilles
Central America
United States

Lobetus Kiesenwetter (9 sp.)

South America (Northwest)

Pseudolobetus Champion (1 sp.)

Panama

Trypherus LeConte (17 sp.)

South America
Central America
United States
Eastern Asia
Philippines

The number of species indicated in each group is based on *Coleopterorum Catalogus* of 1939. Since this publication date a substantial number of species, especially New Guinea members of the genus *Chauliognathus*, have been described. In addition, it is anticipated that certain other genera scattered throughout the family Cantharidae will probably be more cor-

rectly placed with Chauliognathidae. Study material is scarce in museum collections and far larger series than now exist must be assembled before any of these genera can be placed with assurance. Therefore, until a major revision of the Chauliognathidae is made the changes will be deferred.

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NOTES ON COLLECTING CARABIDAE AT AN OATMEAL TRAIL IN OHIO¹

The technique described herein was first used successfully by Hubbell (1956)² for collecting camel crickets of the genus *Ceuthophilus*. He mentions that certain beetles, especially Carabidae, were also attracted to a bait trail of oatmeal or rolled oats.

On the evening of August 24, 1955, the writer placed a trail of rolled oats in a dense hardwood forest in Blendon Woods, Franklin County, Ohio. This bait trail was placed along a path through the woods consisting mainly of beech, hickory and white oak. The rolled